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ANAEROBIC SOIL DISINFESTATION (ASD)

- Developed in the Netherlands and Japan independently ~2000 as a biological alternative to fumigation
- Principle: Acid fermentation in anaerobic soil
- Volatiles and organic acids produced, and microbial community shift taken place during ASD can control a range of soil-borne pathogens



(Van Bruggen, 2014)



(Chiba prefecture, 2002)

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Standard Anaerobic Soil Disinfestation (ASD) for California strawberries

1. Broadcast rice bran at 9 tons/acre in Sep-Oct
2. Incorporate bran
3. List beds
4. Cover w/ plastic mulch
5. Drip irrigate
6. Leave 3 wks and monitor soil Eh (redox potential)



Autumn-bed-rice bran-ASD

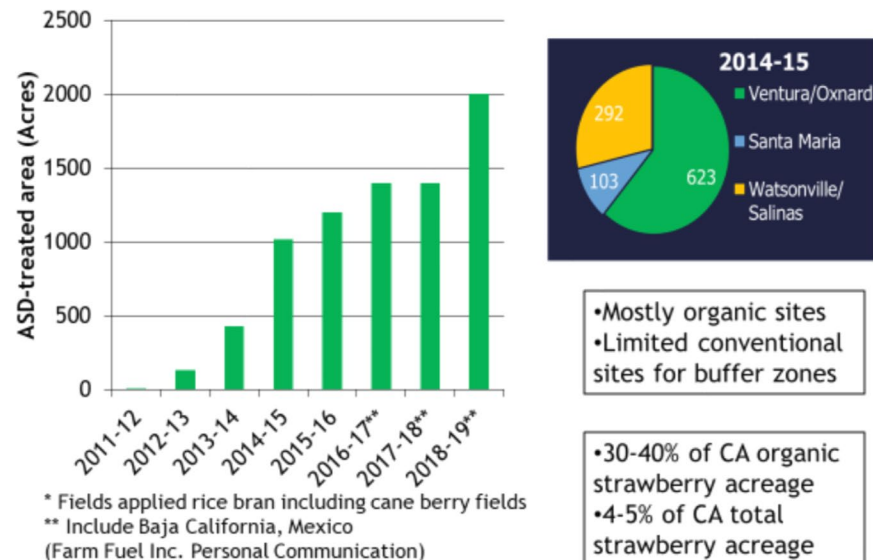
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Yield and disease control by ASD in California strawberries

- Marketable yield: Ave. 99% of fumigated controls in 10 replicated field trials from 2010 to 2015
- Verticillium wilt by *Verticillium dahliae*; 80 to 100% decrease in *V. dahliae* microsclerotia in soil in field trials (Shennan et al., 2018)
- Charcoal rot by *Macrophomina phaseolina*; ~50% reduction of plant mortality compared to un-treated control (Muramoto et al., 2017)
- Fusarium wilt by *Fusarium oxysporum* f. sp. *fragariae* can be controlled by summer-ASD but autumn-ASD can make the disease worse (Muramoto et al., 2017; in review)

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ASD treated acreage in California berry fields*



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Why cover crop ASD?

- To reduce the cost (e.g. Rice bran \$250/ton -> \$300/ton)
- To reduce an external input

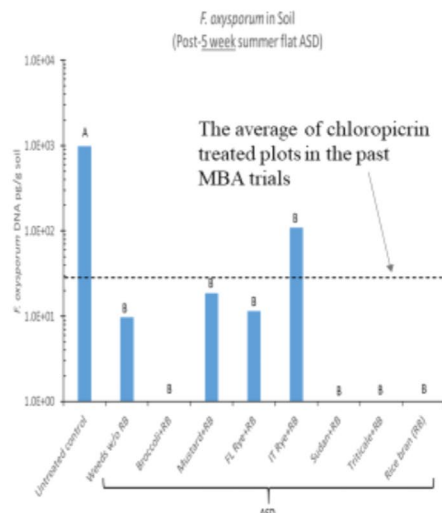
Why partially cover crop?

- The original Dutch ASD method was totally cover crop based, but it has been abandoned....inconsistency in disease control (Meints, 2018)
- Partially replace rice bran with cover crop
 - e.g., 3 tons/acre of cover crop dry biomass
→ 6 tons/acre of rice bran + 3 tons/acre of cover crop

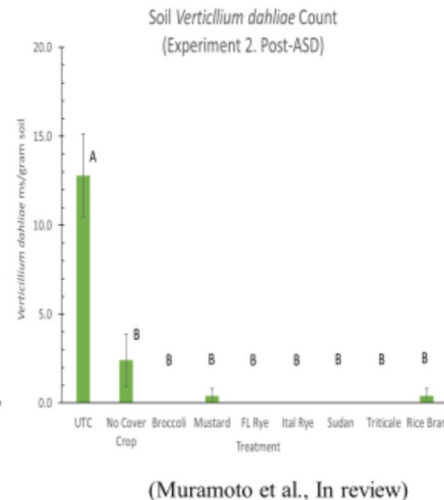
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Effect of Cover crop/Rice bran-ASD

a) Summer-ASD for *Fusarium oxysporum* (field trial)



b) Autumn-ASD for *Verticillium dahliae* (pot trial)



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Types of ASD for California Strawberries

Target pathogen	Season	Field condition	C-sources	Small replicated trial	Commercial scale adoption
<i>Verticillium dahliae</i>	Autumn	Bed	Rice bran	Yes	Yes
	Autumn	Bed	Rice bran+ cover crop/crop residues	Yes	?
<i>Fusarium oxysporum</i> f. sp. <i>fragariae</i>	Summer	Flat	Rice bran (+ cover crop)	Yes	Not yet*
<i>Macrophomina phaseolina</i>	Summer	Flat	Rice bran (+ cover crop)	In-progress	N/A

* Extra tarp and drip tapes are expensive. Also, summer treatment is difficult to perform for many growers

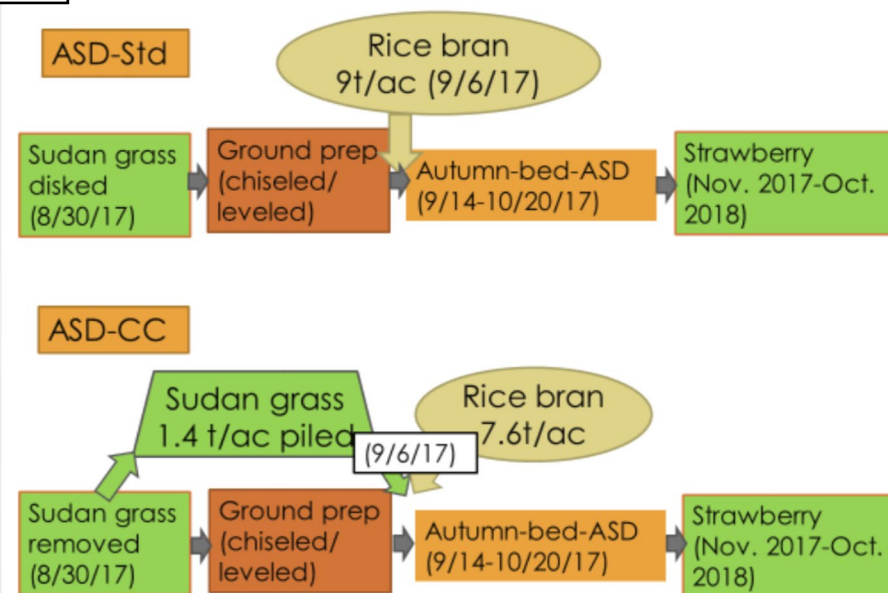
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COVER CROP/CROP RESIDUE-BASED ASD DEMONSTRATION TRIAL

Sandy loam organic field without known soil-borne disease history in Watsonville, CA

- ASD rice bran 9 tons/acre (ASD-Std) vs. ASD cover crop (Sudan grass) 1.4 tons-d.w./acre + rice bran 7.6 tons/acre = 9 tons/acre (ASD-CC)
- Each plot :1 acre. Side-by-side comparison of treatments
- Marketable fruit yield at least weekly, soil inorganic N (0"-12" depth) monthly monitored at 4 pseudo replicates of each plot

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Cover Crop ASD Demo Trial



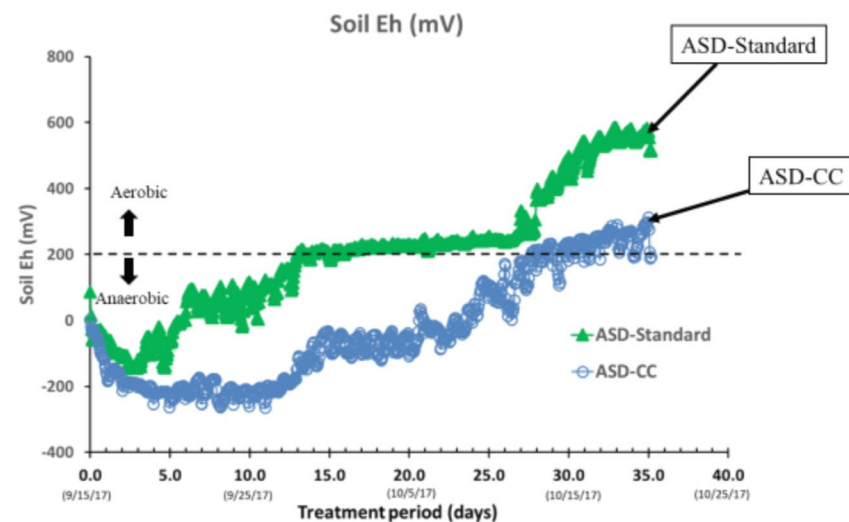
ASD-Std:
Rice bran 9 tons/ac

ASD-CC: Sudan grass
1.4 tons-d.w./ac + rice
bran 7.6 tons/ac



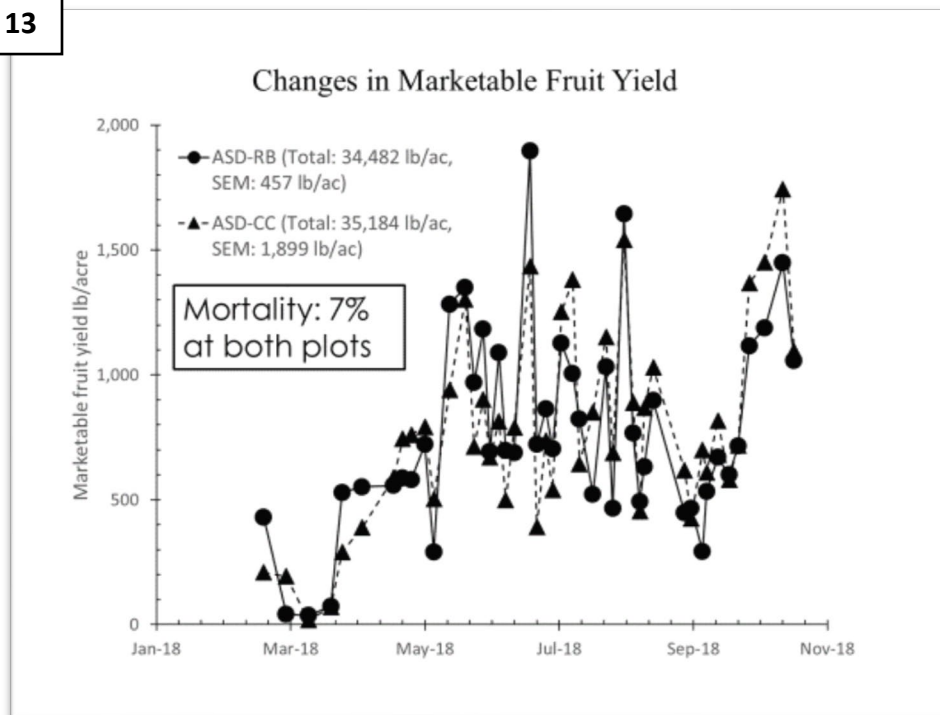
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Cover Crop ASD Demo Trial (1 acre, Watsonville, CA)



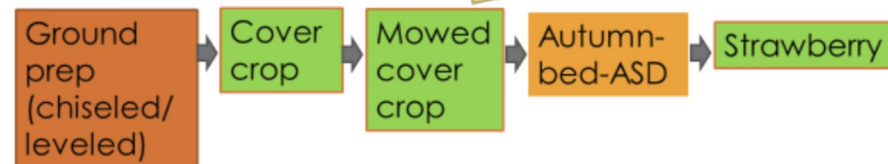
Use of freshly mowed cover crop with reduced rate of rice bran created a stronger anaerobic condition than the standard ASD

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Streamlined
Summer cover
crop ASD system



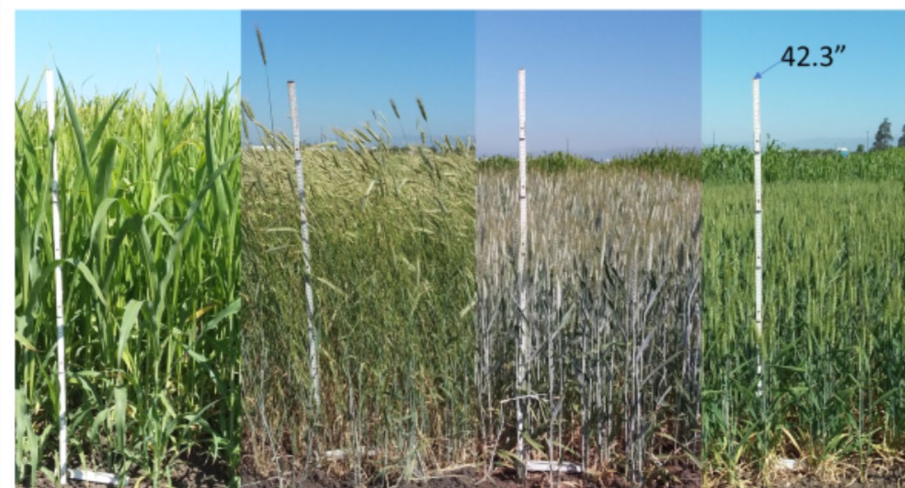
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Summer cover crop-based ASD Trial

- Conventional Salinas clay loam field in Watsonville, CA
- *Macrophomina phaseolina* infested
- Complete Randomized block design with 4 replicates
- Treatments
 - ASD with Sudan Grass (Sweet'n honey) + Rice bran (RB)*
 - ASD with Merced Rye + RB*
 - ASD with Triticale (Pancho) + RB*
 - ASD with Wheat (Summit 515) + RB*
 - ASD with Rice bran 9 tons/ac
 - No carbon source
- * Cover crop + RB = 9 tons/acre
- Cover crop: 5/24/18 – 7/30/18
- Summer-flat-ASD: 8/6/18 – 9/6/18 (clear solarization tarp and Sumisansui irrigation)
- Proprietary strawberry variety : Nov. 2018 – on-going

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Summer Cover Crops at Harvest (7/30/2018)



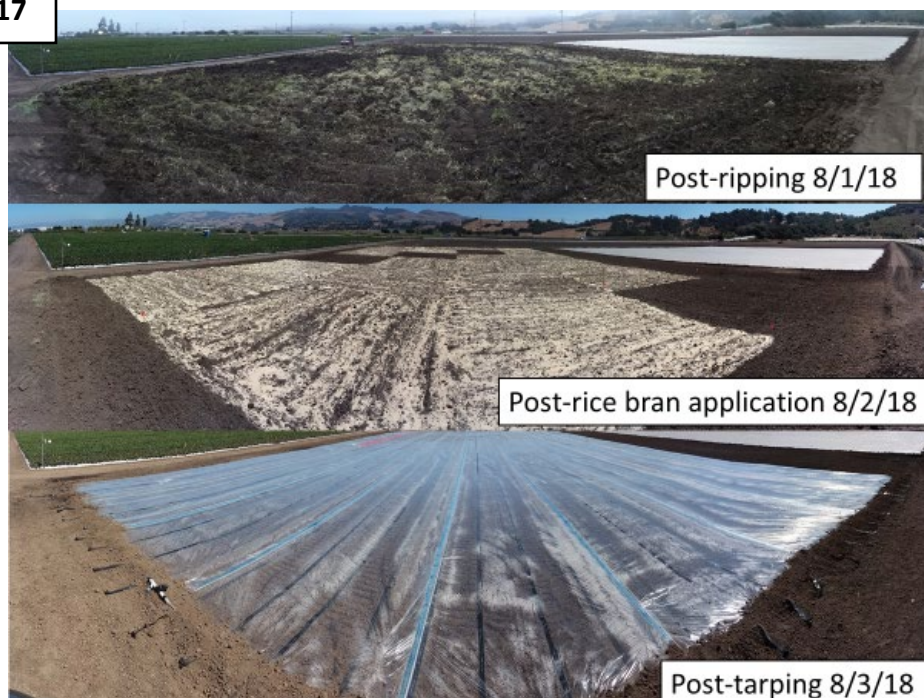
Sudan grass
(Sweet'n honey)
3.9 t-d.w./acre

Merced rye
3.2 t-d.w./ac

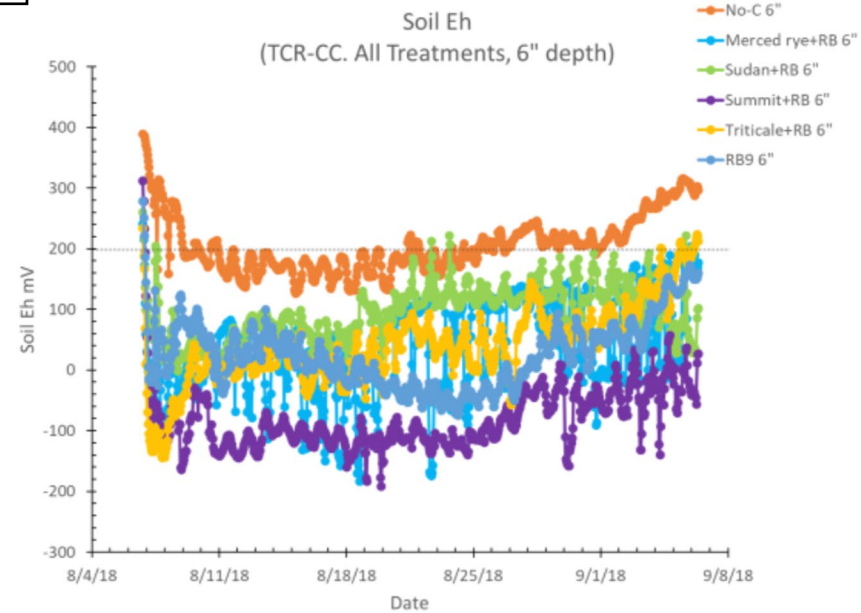
Triticale
(Pancho)
3.5 t-d.w./ac

Wheat
(Summit 515)
3.8 t-d.w./ac

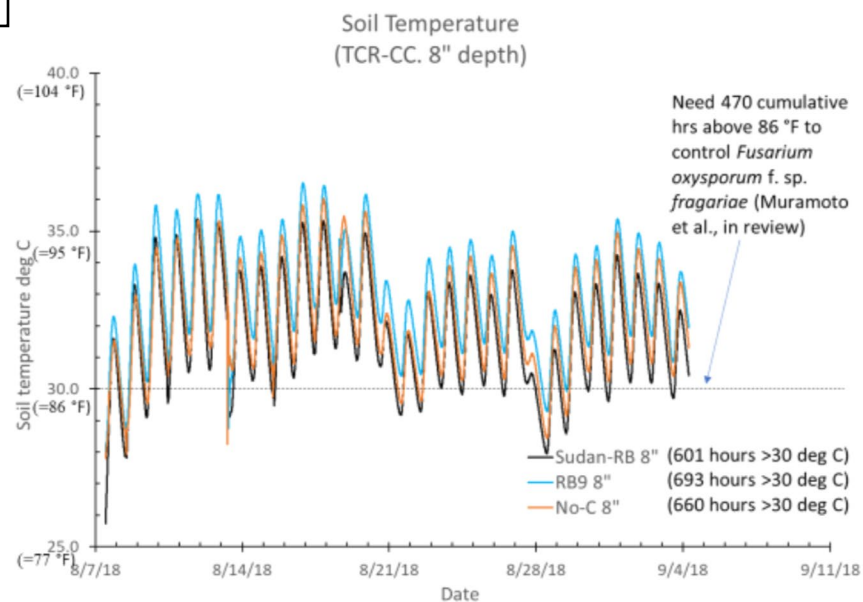
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SUMMER COVER CROP/CROP RESIDUE-BASED ASD

PROS

POTENTIAL TO REDUCE THE COST OF ASD WITHOUT AFFECTING FRUIT YIELD, ITS DISEASE CONTROL ABILITY, AND N PROVISION (BOTH TRIALS TO BE REPEATED IN THE 2018-19 SEASON. ECONOMIC ANALYSIS TO BE DONE)

ASD-CC CAN BE STREAMLINED WITHOUT REQUIRING EXTRA EQUIPMENT (E.G., FORAGE HARVESTER) IF GROUND PREPARATION (E.G., RIPPING, CHISELING AND LEVELING) IS DONE BEFORE PLANTING THE COVER CROP

CON

NOT ALL STRAWBERRY GROWERS CAN GROW A SUMMER COVER CROP

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